Claims

1. A fluid level sensor for use in a fluid container, comprising:

a single ultrasonic transceiver having a measurement section and a reference section separated by an insulating section, said measurement and reference sections are each able to both transmit and receive ultrasonic signals, and

a housing component having both a reference element and an aperture axially spaced from said ultrasonic transceiver, wherein said measurement section transmits ultrasonic measurement signals that pass through said aperture to reflect off of a fluid surface, and said reference section transmits ultrasonic reference signals that reflect off of said reference element.

2. The fluid level sensor of claim 1, wherein said measurement section and said aperture are disk-shaped, said reference section and said reference element are ring-shaped, and all of which are generally concentric.

3. The fluid level sensor of claim 2, wherein said measurement section is located beneath said aperture such that a portion of said ultrasonic measurement signals pass through said aperture, and said reference section is located beneath said reference element such that a portion of said ultrasonic reference signals reflect off of an underside of said reference element.

4. The fluid level sensor of claim 1, wherein said measurement section includes a metalized layer electrically connected to a first electrical lead, and said reference section includes a metalized layer electrically connected to a second electrical lead.

5. The fluid level sensor of claim 4, wherein energization of said first electrical lead causes said measurement section to transmit said ultrasonic measurement signals, and energization of said second electrical lead causes said reference section to transmit said ultrasonic reference signals.

6. The fluid level sensor of claim 1, wherein said ultrasonic transceiver is comprised of a piezo-ceramic composition.

7. The fluid level sensor of claim 1, wherein said fluid level sensor further includes an impedance layer located between said ultrasonic transceiver and the surrounding fluid.

8. The fluid level sensor of claim 7, wherein an upper surface of said ultrasonic transceiver is bonded to a lower surface of said impedance layer.

9. The fluid level sensor of claim 1, wherein said fluid level sensor further includes a damping pad located beneath said ultrasonic transceiver.

10. The fluid level sensor of claim 1, wherein said fluid level sensor is mounted within the fluid container by use of a mounting bracket that includes a retaining element and a linkage component.

11. The fluid level sensor of claim 10, wherein said retaining element is cup-shaped and is closed at a lower axial end and open at an upper axial end such that it may receive said housing component.

12. The fluid level sensor of claim 10, wherein said linkage component includes one or more linkage arms that are biased such that said fluid level sensor is maintained against the bottom of the fluid container.

13. The fluid level sensor of claim 1, wherein said sensor is a fuel level sensor for use in a vehicle fuel tank.

14. The fluid level sensor of claim 13, wherein said fuel level sensor is mounted to a fuel sender unit.

15. The fluid level sensor of claim 13, wherein said fuel level sensor is mounted directly to the bottom of the fuel tank.

16. The fluid level sensor of claim 1, wherein said fluid level sensor is coupled to an electronic controller such that said controller is capable of providing a reference transmission signal and a measurement transmission signal to said sensor that causes said sensor to transmit said ultrasonic reference signals and said ultrasonic measurement signals, respectively, and wherein said fluid level sensor is capable of providing a reference reception signal and a measurement reception signal to said controller upon reception of said ultrasonic reference signals and said ultrasonic measurement signals, respectively.

17. The fluid level sensor of claim 16, wherein said controller is capable of determining the velocity of said ultrasonic reference signals by using the time difference between when said reference transmission signal was sent and when said reference reception signal was received.

18. The fluid level sensor of claim 17, wherein said controller is capable of determining a velocity-corrected fluid level measurement by utilizing the velocity calculation of claim 17 and the time difference between when said measurement transmission signal was sent and when said measurement reception signal was received.

19. A fluid level sensor for use in a fluid container, comprising:

an ultrasonic transceiver having a generally disk-shaped measurement section and a generally ring-shaped reference section, said measurement and reference sections are each able to both transmit and receive ultrasonic signals,

an impedance layer located adjacent said ultrasonic transceiver such that ultrasonic signals transmitted by said measurement and reference sections pass through said impedance layer, and

a housing component having both a reference element and an aperture axially spaced from said ultrasonic transceiver, wherein said measurement section transmits ultrasonic measurement signals that pass through said impedance layer, the fluid and said aperture such that they reflect off of a fluid surface, and said reference section transmits ultrasonic reference signals that pass through said impedance layer and the fluid such that they reflect off of said reference element.

20. The fluid level sensor of claim 19, wherein said measurement section, said reference section, said reference element and said aperture are all generally concentric or coaxial.

21. The fluid level sensor of claim 19, wherein an upper surface of said ultrasonic transceiver includes a first metalized layer that is in electrical communication with said measurement section and a second metalized layer that is in electrical communication with said reference section, and a lower surface of said ultrasonic transceiver includes a metalized layer that is in electrical communication with both said measurement and reference sections.

22. The fluid level sensor of claim 21, wherein said first metalized layer of said upper surface is electrically connected to a first electrical lead, said second metalized layer of said upper surface is electrically connected to a second electrical lead, and said metalized layer of said lower surface is electrically connected to a ground lead.

23. The fluid level sensor of claim 22, wherein energization of said first electrical lead causes said measurement section to transmit said ultrasonic measurement signals, and energization of said second electrical lead causes said reference section to transmit said ultrasonic reference signals.

24. The fluid level sensor of claim 23, wherein said fluid level sensor is coupled to an electronic controller such that said controller is capable of providing a reference transmission signal and a measurement transmission signal to said sensor that causes said sensor to transmit said ultrasonic reference signals and said ultrasonic measurement signals, respectively, and wherein said fluid level sensor is capable of providing a reference reception signal and a measurement reception signal to said controller upon reception of said ultrasonic reference signals and said ultrasonic measurement signals, respectively.

25. The fluid level sensor of claim 24, wherein said controller is capable of determining the velocity of said ultrasonic reference signals by using the time difference between when said reference transmission signal was sent and when said reference reception signal was received.

26. The fluid level sensor of claim 25, wherein said controller is capable of determining a velocity-corrected fluid level measurement by utilizing the velocity calculation of claim 25 and the time difference between when said measurement transmission signal was sent and when said measurement reception signal was received.

27. The fluid level sensor of claim 19, wherein said impedance layer is integrally formed with said housing component.

28. The fluid level sensor of claim 19, wherein said sensor is a fuel level sensor for use in a vehicle fuel tank.

29. A method for measuring the fuel level within a vehicle fuel tank, comprising the steps of:

(a) providing a fuel level sensor having ultrasonic measurement and reference sections,

(b) providing a reference element located at a known distance from said ultrasonic reference section,

(c) causing said ultrasonic reference section to emit ultrasonic reference signals that pass through the fuel to reflect off of said reference element,

(d) determining the roundtrip echo time of said ultrasonic reference signals,

(e) causing said ultrasonic measurement section to emit ultrasonic measurement signals that pass through the fuel to reflect off of a surface of the fuel,

(f) determining the roundtrip echo time of said ultrasonic measurement signals,

(g) determining whether the surface of the fuel is at a level that is at or below said reference element, and

(h) if the surface of the fuel is above said reference element then determining a fuel level measurement based on the roundtrip echo times of both said ultrasonic reference and measurement signals, and if the surface of the fuel is at or below said reference element then determining a fuel level measurement based on the roundtrip echo time of said ultrasonic measurement signal and a default ultrasonic signal velocity.

30. The method of claim 29, wherein said default ultrasonic signal velocity is based upon a predetermined fixed velocity value.

31. The method of claim 29, wherein said default ultrasonic signal velocity is based upon the last calculated velocity value that was valid.

32. The method of claim 29, wherein said fuel level measurement must fall within a range of predetermined values.

33. The method of claim 29, wherein said ultrasonic reference signals are emitted sequentially with respect to said ultrasonic measurement signals.

34. The method of claim 29, wherein said method further comprises the steps of:

(i) storing said fuel level measurement,

(j) determining a second fuel level measurement, and

(k) if said second measurement is greater than said stored measurement then incrementing said stored measurement by a predetermined step value, if said second measurement is equal to said stored measurement then keeping said stored measurement the same, and if said second measurement is less than said stored measurement then decrementing said stored measurement by a predetermined step value.

35. The method of claim 34, wherein said predetermined step values for incrementing and decrementing are unequal.

36. The method of claim 29, wherein said method further comprises the step of determining the signal velocity of said ultrasonic reference signal by using said roundtrip echo time of said ultrasonic reference signals and said known distance between said ultrasonic reference section and said reference element.

37. The method of claim 36, wherein said method further comprises the step of determining the temperature of the fuel by using said signal velocity.

38. The method of claim 29, wherein said method further comprises the step of continuously storing said fuel level measurement such that if power is removed, the last stored measurement may be reported.

39. The method of claim 38, wherein said fuel level measurement is stored by using a technique that reduces the number of write cycles to a non-volatile memory device.

40. A fluid level sensing system for use with a fluid container, comprising:
a fluid level sensor mounted towards the bottom of the fluid container, said sensor comprising:

an ultrasonic transceiver having generally concentric measurement and reference sections that are each capable of both transmitting and receiving ultrasonic signals within a fluid, and

a housing component that at least partially surrounds said ultrasonic transceiver and has both a reference element and an aperture, said measurement section transmits ultrasonic signals that pass through the fluid and said aperture to reflect off of a fluid surface and said reference section transmits ultrasonic signals that pass through the fluid to reflect off of said reference element, and

an electronic controller, wherein said controller is capable of providing a signal velocity calibrated measurement of the fluid level within the fluid container that is based upon said ultrasonic signals provided by said measurement and reference sections.